Morphology of silanol end-terminated poly(styrene-co-butadiene) random copolymer thin films and nanostructures on a mica surface

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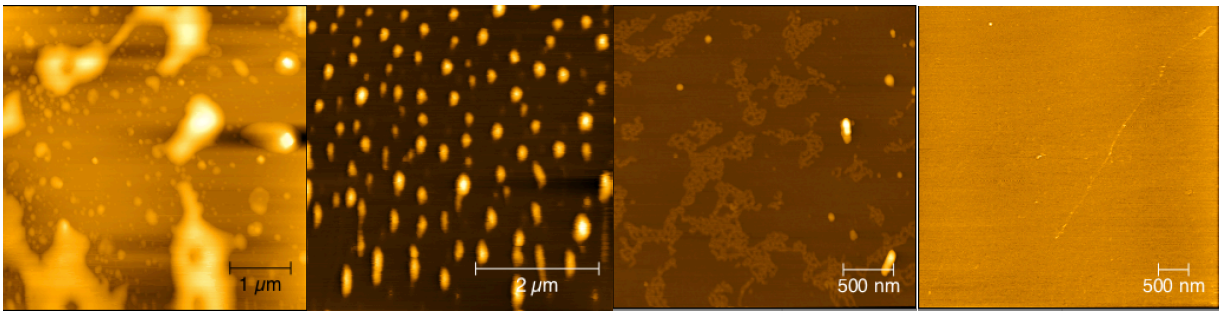
ABSTRACT

Poly(styrene-co-butadiene) is a synthetic rubber that is widely used by the automotive industry for the manufacturing of tyres due to its abrasion resistance and good aging stability when protected by additives such as carbon black or silica [1]. This work aims to investigate the morphology of silanol end terminated poly(styrene-co-butadiene) nanostructures on mica at various concentrations using atomic force microscopy. Solutions of the polymer were prepared using toluene (a good solvent) at the critical overlap concentration (c*), where chains in solution begin to overlap with one another [2] and at 0.1c*,0.01c* and 0.001c*. The solutions were then spin coated onto freshly cleaved mica, a substrate which due to its atomically flat surface allows us to easily observe the conformations of the polymer using an atomic force microscope (AFM) [3]. At the critical concentration an ultra-thin film was observed with a thickness of approximately 15nm. At 0.1c* spherical aggregates started forming with their average height around 10nm. By diluting the solution ten times further fewer and smaller aggregates were observed (about 5nm in height) with monolayers of entangled chains observed at various regions of the substrate, their height being around 1nm. Finally, at the lowest concentration tested (0.001c*) the AFM was able to detect what appear to be single polymer chains in a rectilinear conformation with their approximate length being around 5μm and a height of less than a nanometer. Measuring the thickness of poly(styrene-co-butadiene) monolayers and being able to observe single chains of this polymer provides us with further insight into the morphology of polymers at the nanoscale. Finally, we have seen of how a basic parameter such as concentration can have a significant impact on the conformation of the polymer on a surface.



(a) (b) (c) (d)

Figure: AFM height images of end terminated silanol poly(styrene-co-butadiene) on mica at c*, 0.1c*, 0.01c* and 0.001c* respectively.

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